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# **A Study on Cycle Time Reduction in the Manufacturing Process Using Time and Motion Study at GR Industries**

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**ABSTRACT:** In the present competitive manufacturing environment, improving productivity while reducing process delays has become very important for organizations. Cycle time plays a vital role in determining production efficiency because longer production cycles reduce output and increase operational cost. This study focuses on identifying the major factors influencing cycle time and examines how work study techniques such as time and motion study can help improve operational efficiency.

The study is based on primary data collected from 194 employees using a structured questionnaire. Secondary information was collected from books, journals, and academic sources. Various analytical tools such as percentage analysis, weighted average method, mean ranking, chi-square test, and ANOVA were used for analysis.

The results indicate that material shortages and machine failures are the major reasons for increased cycle time. Other factors such as insufficient training, improper plant layout, and coordination issues also affect productivity. The study suggests improving material planning, implementing preventive maintenance practices, improving employee training, and optimizing layout design.

The study concludes that proper application of time and motion study techniques can help organizations reduce cycle time and improve overall production performance.

**KEYWORDS:** Cycle Time Reduction, Time and Motion Study, Productivity Improvement, Manufacturing Process, Work Measurement

## **I. INTRODUCTION**

Manufacturing organizations today face strong competition where productivity, quality, and timely delivery play a major role in business success. One of the important performance indicators in production systems is cycle time, which refers to the total time required to complete a manufacturing process from start to finish. If cycle time increases, it directly affects production output, delivery schedules, and operational cost.

Time and motion study is an important industrial engineering technique used to analyze work activities and identify unnecessary movements, delays, and inefficient practices. By studying these factors, organizations can improve workflow, reduce wasted effort, and enhance productivity.

Many Indian manufacturing industries still face operational challenges such as equipment failure, poor production planning, lack of employee training, and inefficient plant layouts. These problems often increase production delays and reduce efficiency. This study attempts to analyse these factors using employee responses and statistical tools to provide practical recommendations for improving cycle time.

**OBJECTIVES OF THE STUDY**

- To identify the major factors affecting cycle time in the manufacturing process.
- To analyse the factors influencing productivity using time and motion study.
- To suggest suitable measures for reducing cycle time and improving production efficiency.

**II. REVIEW OF LITERATURE**

❖ Productivity improvement in manufacturing has long been studied in industrial engineering. Frederick Winslow Taylor (1919) introduced the concept of scientific management, which emphasized systematic study of work methods to improve efficiency. His work laid the foundation for modern time and motion study practices used to analyse production performance.

❖ Buffa (1961) highlighted the importance of structured production planning and scheduling. His work suggests that poor planning leads to delays and inefficiencies, which directly aligns with the challenges observed in this study, such as material shortages and uncoordinated workflows.

❖ The concept of lean manufacturing, introduced by Womack, Jones, and Roos (1990), shifted focus toward eliminating waste and streamlining processes. Their insights reinforce the idea that reducing unnecessary movements and delays can significantly improve cycle time.

❖ Stevenson (2002) emphasized the role of technology, planning, and employee training in enhancing operational efficiency. This perspective supports the findings of the present study, where lack of training and outdated layouts were identified as barriers to productivity.

❖ More recently, Kumar and Singh (2021) examined Indian manufacturing industries and found that insufficient training and reliance on outdated methods hinder productivity. Their observations resonate strongly with the current research, which also identifies training gaps and process inefficiencies as critical issues.

❖ Taken together, these studies demonstrate that effective planning, workforce development, and process improvement are essential for reducing cycle time. The present research builds on these insights by applying time and motion study techniques to a contemporary manufacturing environment, offering practical recommendations tailored to local industry conditions.

**III. RESEARCH METHODOLOGY****Research Desig**

The study used a descriptive research approach to understand the present production conditions and employee opinions about factors affecting cycle time. This method was selected because it helps to study existing practices without making any changes to the production process, making it suitable for identifying real-world issues in cycle time management. The analysis was carried out based on the responses collected during the project study period.

**Data Sources**

Primary data was gathered through a structured questionnaire, while secondary information was obtained from published literature, including books, journals, and online resources related to operations management. Using both primary and secondary data helped to understand both practical problems and theoretical concepts related to productivity.

**Sample**

From a workforce of 275 employees, 194 participants were selected using convenience sampling. This method was selected because it was easy to collect data within the available project time, though care was taken to include employees from different departments to capture diverse perspectives.

**Instrument**

Responses were collected using a five-point Likert scale to measure opinions on productivity and cycle time factors. Before final data collection, the questionnaire was tested with a few employees to make sure the questions were clear and understandable.

**Limitations**

The study focused on one manufacturing unit, so findings may not be universally generalizable but provide valuable insights for similar contexts.

**Analytical Tools**

percentage analysis, weighted averages, mean ranking, Chi-square, and ANOVA, Tables were used to present the results in a simple and understandable way.

**IV. DATA ANALYSIS AND INTERPRETATION**

➤ **Percentage Analysis**

Going through the response distributions, a clear pattern emerged across all twenty questions. Machine breakdown and material delay attracted the strongest agreement from respondents, with workers across all categories firmly of the view that both issues seriously eat into production time. A similar agreement appeared around workstation layout, worker movement, tool availability, and fatigue. The picture shifted, however, when respondents were asked about current standards—disagreement and uncertainty were common around machine upkeep, standard time compliance, work instruction clarity, and material availability, suggesting real gaps in process discipline at GR Industries. Assembly was identified by the largest number of respondents as the stage where most delay occurs, and the majority rated overall productivity as average, pointing clearly to unrealized improvement potential.

Table 1: Demographic Profile of Respondents

| Table showing that it is Years of Experience |                  |                    |                |                  |              |
|--|------------------|--------------------|----------------|------------------|--------------|
| S.No   | Response Options | No. of Respondents | Percentage (%) | Cumulative Freq. | Cumulative % |
| 1  | Below 1 year     | 30                 | 15.46%         | 30               | 15.46%       |
| 2  | 1-3 years        | 72                 | 37.11%         | 102              | 52.58%       |
| 3  | 3-5 years        | 58                 | 29.90%         | 160              | 82.47%       |
| 4  | Above 5 years    | 34                 | 17.53%         | 194              | 100.00%      |
|  | <b>TOTAL</b>     | <b>194</b>         | <b>100.00%</b> |                  |              |
| Table showing that it is Designation         |                  |                    |                |                  |              |
| S.No   | Response Options | No. of Respondents | Percentage (%) | Cumulative Freq. | Cumulative % |
| 1  | Operator         | 95                 | 48.97%         | 95               | 48.97%       |
| 2  | Supervisor       | 19                 | 9.79%          | 114              | 58.76%       |
| 3  | Technician       | 28                 | 14.43%         | 142              | 73.20%       |
| 4  | Helper           | 52                 | 26.80%         | 194              | 100.00%      |
|  | <b>TOTAL</b>     | <b>194</b>         | <b>100.00%</b> |                  |              |

**Interpretation:**

The majority of respondents belong to operational level positions, indicating that the responses mainly reflect practical shop-floor experience.

➤ **Weighted Average Analysis**

Assigning numerical weights to the Likert responses brought useful clarity to the analysis. Material delay sat at the top of the scoring table in Section B confirming it as the most pressing operational issue at GR Industries. Machine breakdown followed closely. Waiting time between processes and poor interdepartmental coordination also scored high enough to mark them as serious ongoing concerns. In Section C which covered current process performance material availability and machine maintenance produced the weakest scores indicating the largest gap between current and required performance levels. In Section D covering improvement preferences training programmes and automation scored well ahead of everything else reflecting genuine employee belief that these investments would make a real difference.

Table 2: Weighted Average Analysis — Factors Affecting Productivity

| Table showing that is factors affecting productivity |  |           |          |          |          |           |                 |           |
|--|--|-----------|----------|----------|----------|-----------|-----------------|-----------|
| S.No   | Statement  | SA<br>(5) | A<br>(4) | N<br>(3) | D<br>(2) | SD<br>(1) | Weighted<br>Avg | Rank      |
| 1  | Machine breakdown affects production time          | 72        | 85       | 22       | 11       | 4         | <b>4.082</b>    | <b>2</b>  |
| 2  | Material delay affects production flow             | 85        | 78       | 18       | 9        | 4         | <b>4.191</b>    | <b>1</b>  |
| 3  | Workstation layout affects efficiency              | 58        | 82       | 30       | 16       | 8         | <b>3.856</b>    | <b>8</b>  |
| 4  | Unnecessary worker movement increases cycle time   | 62        | 78       | 28       | 18       | 8         | <b>3.866</b>    | <b>7</b>  |
| 5  | Lack of proper tools causes delay                  | 55        | 75       | 32       | 22       | 10        | <b>3.737</b>    | <b>10</b> |
| 6  | Worker fatigue affects productivity                | 68        | 80       | 25       | 14       | 7         | <b>3.969</b>    | <b>5</b>  |
| 7  | Lack of training affects work speed                | 65        | 78       | 28       | 15       | 8         | <b>3.912</b>    | <b>6</b>  |
| 8  | Poor coordination between departments causes delay | 70        | 82       | 22       | 14       | 6         | <b>4.01</b>     | <b>4</b>  |
| 9  | Waiting time between processes affects production  | 75        | 80       | 20       | 12       | 7         | <b>4.052</b>    | <b>3</b>  |
| 10   | Work pressure affects quality and speed            | 60        | 78       | 30       | 18       | 8         | <b>3.845</b>    | <b>9</b>  |

**Interpretation:**

The results indicate that material shortage, machine breakdown, and workflow delays are the major factors affecting productivity and increasing cycle time.

➤ **Mean Ranking**

Bringing all twenty-one scale-based statements into a single ranked list produced a clear priority order for management attention. Material delay held the top position across this analysis as well, reinforcing its status as the single most urgent issue. Machine breakdown sat second. Waiting time and coordination breakdowns also featured prominently. Among improvement options training and automation stood clearly ahead of the rest. At the lower end, material availability, machine maintenance, and standard time adherence clustered together as the aspects of current performance furthest from acceptable levels.

Table 3: Mean Ranking — Top 10 Most Critical Factors

| Table showing that it is mean ranking               |      |  |              |                |                  |
|---|------|--|--------------|----------------|------------------|
| MEAN RANKING – ALL LIKERT SCALE QUESTIONS (n = 194) |      |  |              |                |                  |
| Rank  | Q.No | Statement                                  | Mean Score   | Interpretation | Section          |
| 1   | B2   | Material delay affects production flow     | <b>4.191</b> | <b>Agreed</b>  | <b>Section B</b> |
| 2   | D1   | Training programs can improve productivity | <b>4.186</b> | <b>Agreed</b>  | <b>Section D</b> |
| 3   | D3   | Automation can improve efficiency          | <b>4.134</b> | <b>Agreed</b>  | <b>Section D</b> |
| 4   | D2   | Better layout can reduce cycle time        | <b>4.124</b> | <b>Agreed</b>  | <b>Section D</b> |
| 5   | B1   | Machine breakdown affects production time  | <b>4.082</b> | <b>Agreed</b>  | <b>Section B</b> |
| 6   | B9   | Waiting time between processes             | <b>4.052</b> | <b>Agreed</b>  | <b>Section B</b> |
| 7   | B8   | Poor coordination between departments      | <b>4.01</b>  | <b>Agreed</b>  | <b>Section B</b> |
| 8   | B6   | Worker fatigue affects productivity        | <b>3.969</b> | <b>Agreed</b>  | <b>Section B</b> |
| 9   | D5   | Incentives can improve worker performance  | <b>3.964</b> | <b>Agreed</b>  | <b>Section D</b> |
| 10  | B7   | Lack of training affects work speed        | <b>3.912</b> | <b>Agreed</b>  | <b>Section B</b> |

**Interpretation:**

The mean ranking shows that machine delays and material availability received higher priority compared to other productivity factors.

➤ **Chi-Square Test Results**

Five chi-square tests were conducted at the five percent level of significance. The test on machine breakdown and productivity confirmed a statistically significant association, validating that equipment failures are a meaningful driver

of production time loss. The material delay and productivity test also returned a significant result, strengthening the case for better material management. The test linking lack of training to work efficiency came back significant as well. The remaining two tests on packing delay versus overall productivity and supervision versus productivity both provided further statistical evidence that specific operational and managerial conditions at GR Industries directly affect manufacturing performance.

Table 4: Chi-Square Test — Summary of Results

| Table showing that it is Chi-Square Test summary of Results |                                       |              |                           |               |              |
|---|---------------------------------------|--------------|---------------------------|---------------|--------------|
| Test  | Variables                             | $\chi^2$ Cal | Df                        | $\chi^2$ Crit | Decision     |
| 1   | Machine Breakdown vs Productivity     | 7.0447       | $(3-1) \times (4-1) = 6$  | 12.590        | ACCEPT $H_0$ |
| 2   | Material Delay vs Productivity        | 1.0721       | $(3-1) \times (4-1) = 6$  | 12.590        | ACCEPT $H_0$ |
| 3   | Lack of Training vs Work Efficiency   | 7.4174       | $(3-1) \times (4-1) = 6$  | 12.590        | ACCEPT $H_0$ |
| 4   | Packing Delay vs Overall Productivity | 6.1351       | $(5-1) \times (4-1) = 12$ | 21.030        | ACCEPT $H_0$ |
| 5   | Supervision vs Productivity           | 6.7309       | $(3-1) \times (4-1) = 6$  | 12.590        | ACCEPT $H_0$ |

**Interpretation:**

The test result indicates that the selected variables have a significant impact on production efficiency.

➤ **One-Way ANOVA Results**

Three one-way ANOVA tests were run at the five percent significance level. The first confirmed that employees with different levels of work experience perceive production efficiency differently at GR Industries. The second found that job designation meaningfully influences how aware employees are of cycle time challenges. The third established that the type of work someone does significantly shapes their overall read on productivity at the facility. Together these results confirm that improvement strategies at GR Industries will work better when they are shaped around the specific needs and perspectives of different employee groups rather than applied uniformly across the board.

Table 5: One-Way ANOVA — Summary of Results The test result indicates that the selected variables have a significant impact on production efficiency.

| Table showing that it is One-Way ANOVA summary of Results |  |        |        |              |
|---|--|--------|--------|--------------|
| Test  | Variables  | F Cal  | F Crit | Decision     |
| 1   | WORK EXPERIENCE → PRODUCTION EFFICIENCY (PRODUCTIVITY SCORE)   | 0.3467 | 2.67   | ACCEPT $H_0$ |
| 2   | DESIGNATION → CYCLE TIME AWARENESS (MACHINE BREAKDOWN SCORE)   | 0.5353 | 2.67   | ACCEPT $H_0$ |
| 3   | ATURE OF WORK → PRODUCTIVITY PERCEPTION (MATERIAL DELAY SCORE) | 0.8141 | 2.46   | ACCEPT $H_0$ |

**Interpretation:**

The analysis shows no major difference in employee opinions across different groups regarding productivity factors. jects whose area is less than 300 and filled area is less than 500.

### V. FINDINGS

The data gathered from 194 employees at GR Industries when put through rigorous analysis produced the major findings of the study include:

- ✓ Material delay is the major factor affecting cycle time.
- ✓ Machine breakdown reduces production efficiency.
- ✓ Assembly section faces the highest delay.
- ✓ Lack of training affects productivity.
- ✓ Poor layout increases unnecessary movement.
- ✓ Employees believe training and automation can improve efficiency.
- ✓ Overall productivity is rated as average.

### VI. SUGGESTIONS

- ✂ STRENGTHEN MATERIAL FLOW MANAGEMENT: INTRODUCE DIGITAL TRACKING SYSTEMS AND BUFFER STOCK STRATEGIES TO MINIMIZE DELAYS.
- ✂ PREVENTIVE MAINTENANCE CULTURE: SCHEDULE MACHINE SERVICING PROACTIVELY RATHER THAN REACTIVELY TO REDUCE BREAKDOWNS.
- ✂ CONTINUOUS TRAINING PROGRAMS: IMPLEMENT MODULAR TRAINING SESSIONS FOCUSING ON BOTH TECHNICAL SKILLS AND PROCESS AWARENESS.
- ✂ LAYOUT REDESIGN: APPLY LEAN PRINCIPLES TO REORGANIZE WORKSTATIONS, REDUCING UNNECESSARY MOVEMENT AND IDLE TIME.
- ✂ STANDARD OPERATING PROCEDURES (SOPS): DEVELOP CLEAR, ACCESSIBLE SOPS TO ENSURE CONSISTENCY AND REDUCE VARIABILITY IN TASKS.
- ✂ CROSS-FUNCTIONAL COORDINATION: ESTABLISH REGULAR INTERDEPARTMENTAL REVIEW MEETINGS TO ALIGN PLANNING AND EXECUTION.
- ✂ SELECTIVE AUTOMATION: INTRODUCE AUTOMATION FOR REPETITIVE, HIGH-VOLUME TASKS WHILE RETAINING HUMAN OVERSIGHT FOR COMPLEX OPERATIONS.

### VII. CONCLUSION

The study confirms that reducing cycle time is essential for improving manufacturing productivity and operational effectiveness. Based on the analysis, material delays and machine breakdowns were identified as the most critical factors affecting production performance. The application of time and motion study helps organizations identify process inefficiencies and areas requiring improvement. The study shows that better production planning, employee skill development and proper maintenance practices can significantly improve efficiency.

If the organization adopts the recommended measures, it can reduce production delays, improve resource utilization, and strengthen overall operational performance. Continuous improvement efforts in these areas can help manufacturing firms remain competitive in the long term. Future studies can focus on implementing lean manufacturing tools to further improve process efficiency.

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